

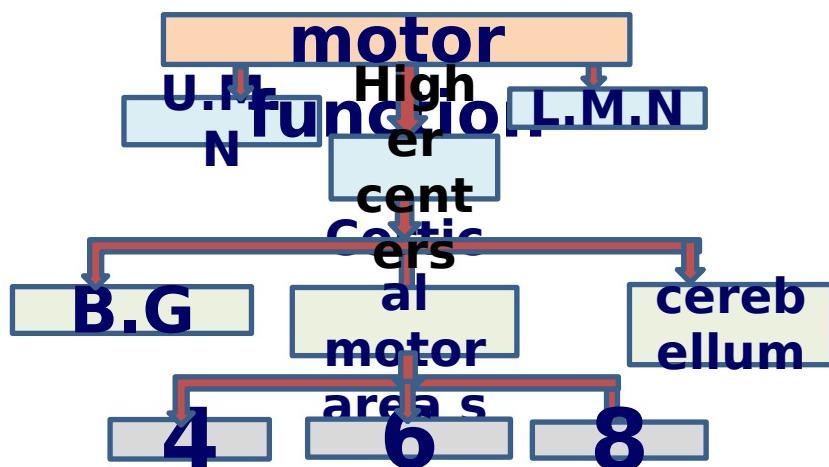
The motor descending tracts

INTENDED LEARNING OBJECTIVES (ILOs)

By the end of this lecture the student will be able to:

1. Explain the physiological significances of the descending motor tracts (Corticospinal tract , and Corticobulbar tracts)
2. Differentiate between medial and lateral descending brain stem pathways involved in motor control.
3. Describe physiological role of medial descending system: pontine and medullary reticulospinal, vestibulospinal, and tectospinal in motor control
4. Describe physiological role of Lateral descending system in motor control
5. Explain the mechanism of cortical control on axial and distal muscles.

Control of



SOMATOC MOTOR SYSTEM

Function

Control of skeletal muscle activity to produce:

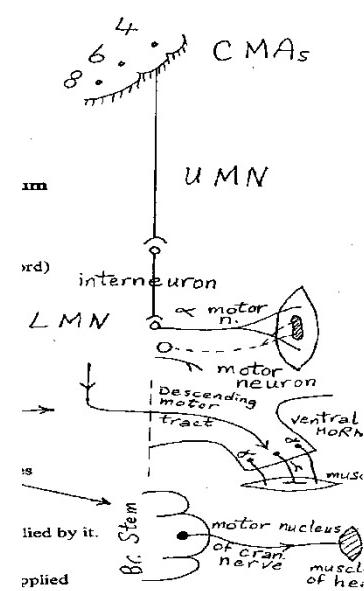
- Muscle tone.
- Movement : voluntary movement and reflex action.

Voluntary Movement:

It is purposeful movement correctly ordered in time and space.

Reflex Action:

It is a subconscious response due to stimulation of receptor.



UMN (Upper motor neuron):

From level of the cortical motor areas down till A.H.C. (Sp. Cord) or cranial motor nuclei (Br. Stem). It includes:

1. Pyramidal tracts.
2. Extra Pyramidal tracts.

LMN (Lower motor neuron):

It is the final common pathway for skeletal muscle activity.

LMNs of Body Muscles

Ventral Horn → A.H.C. → it's axon (peripheral n.) → muscle on same side._

- LMNs of Head Muscles:

Motor nucleus of cranial nerve in brain stem → cranial nerves (all except 1,2,8) → head muscles on same side.

There are 2 main systems:

A- Pyramidal tracts:

1. Corticospinal (lateral, medial and uncrossed)
2. Corticobulbar

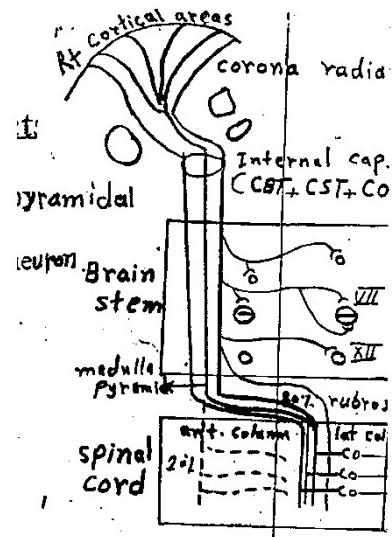
B- Extra pyramidal tracts:

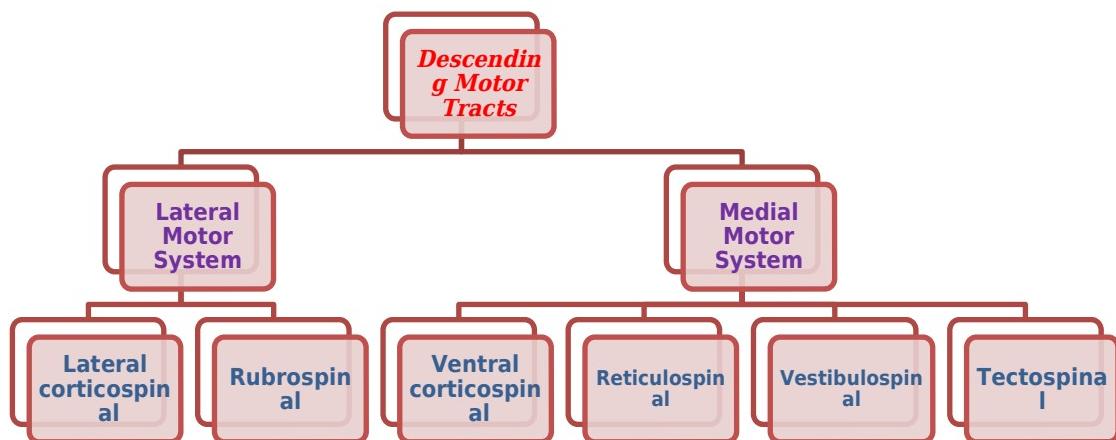
All descending tracts other than pyramidal tracts

1. Rubrospinal
2. Vestibulospinal
3. Tectospinal
4. Reticulospinal

According to their position in spinal cord and anterior horn cells they are divided into:

1. Lateral motor system
2. Medial motor system





	Medial Motor System	Lateral Motor System
Site of termination	Medial or ventral portion of anterior horn	Lateral portion of anterior horn
Muscles innervated	Trunk muscles Proximal limb muscles	Distal limb muscles
Function	Controls gross movements Controls body posture Provides stable background during performance of fine movements by distal limb muscles	Controls fine, skilled (discrete) voluntary movements
Tracts Involved	Ventral corticospinal tract Reticulospinal tracts Vestibulospinal tracts Tectospinal tract	Lateral corticospinal tract Rubrospinal tract

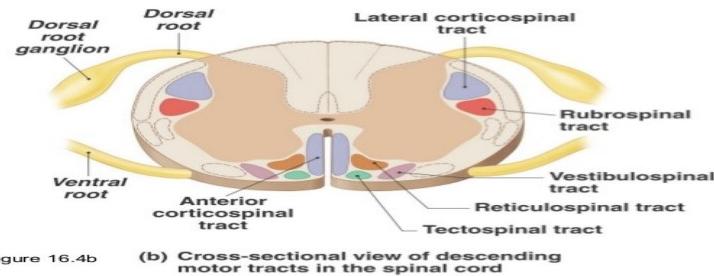


Figure 16.4b (b) Cross-sectional view of descending motor tracts in the spinal cord

Locations of major descending motor tracts that contain axons of upper motor neurons

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Pyramidal System (Direct Activation Pathway)

One tract of 2 or 3 parts:

1. Corticospinal tract: Control LMNs of body muscles.

2. Corticobulbar tract:

Ends in brain stem, controls LMNs of cranial nerves supplying head muscles

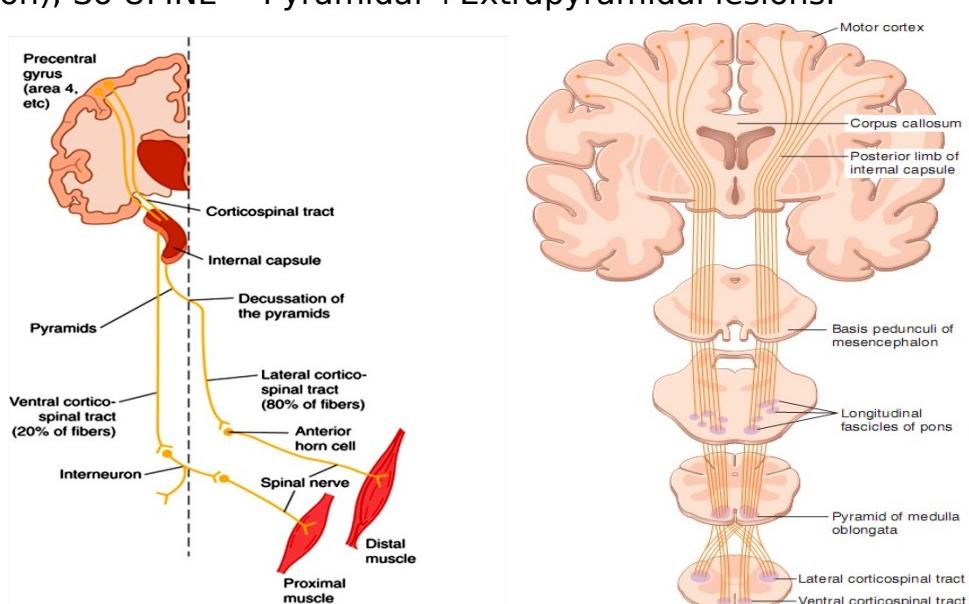
(V, VII, IX, X, XII) on the same and opposite sides, except the lower part of VII and XII nerves (contra lateral).

3. Corticorubrospinal tract:

Controls LMNs of cranial nerves supplying extra-ocular muscles of the eye (III, IV, VI).

CST (Corticospinal tract) :arises from cerebral cortex to reach A.H.C. without relay in-between.

N.B. Pure pyramidal Fibers (CST) only in the pyramid of Medulla, (no pure pyramidal lesion); So UMNL = Pyramidal +Extrapyramidal lesions.



Function of Pyramidal tract:

1. Performance of fine discrete voluntary movement of head muscles (CBT)

2. CST for body muscles:
 - Lateral corticospinal tract: Primary pathway for initiation of skilled voluntary movements
 - Ventral corticospinal tract: Postural adjustments
3. Excitatory to alpha motor neuron:
 - Increased muscle tone.
 - Increased tendon jerks.
4. Necessary for superficial reflexes.
5. Necessary for flexor plantar response.

Lesion of Pyramidal tract:

1- Lesion of Lateral Corticospinal Tract

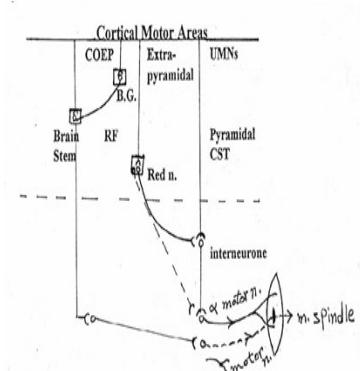
- o Loss of fine movements of fingers and hands
- o Intact wrist movements

2- Lesion of Ventral Corticospinal Tract

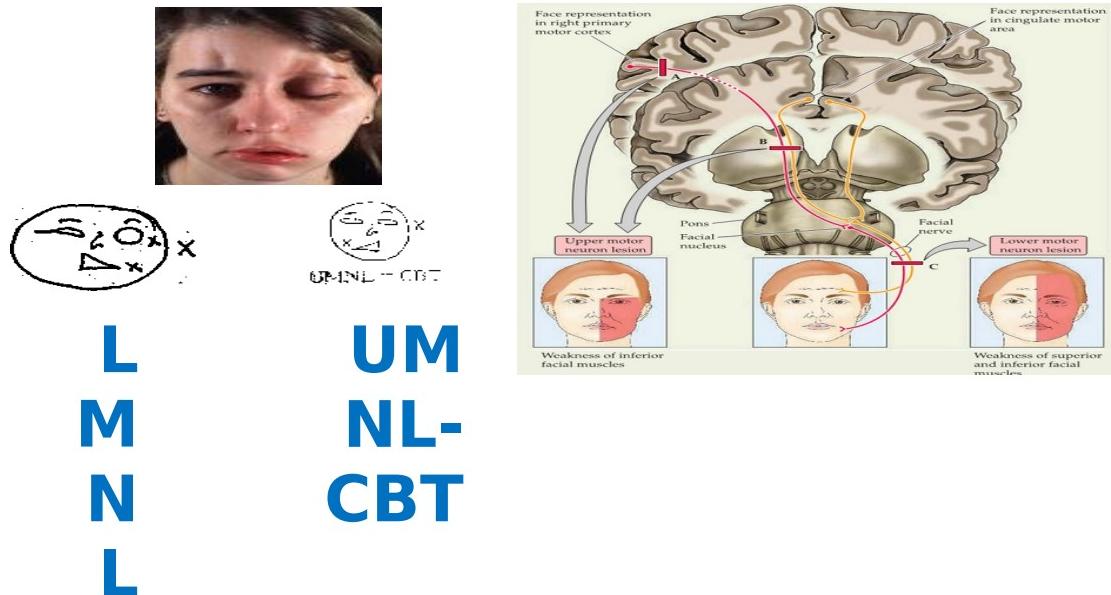
- o Axial muscle deficits
- o Difficulty with balance, standing and walking

3- Lesion in Corticobulbar tract: Upper face is spared

N.B LMNL = Facial Palsy half of the face is affected



4- Lesion in corticonuclear tract: loss of conjugate movement of eye balls.



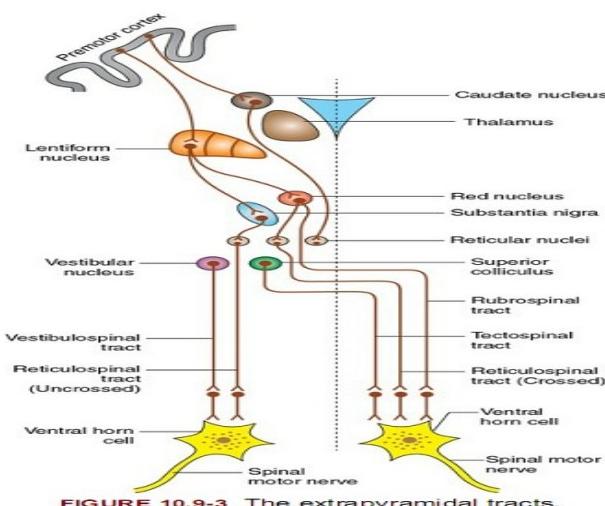
Extra pyramidal System (Indirect Activation Pathway)

Of multiple origins:

1. CMAs(COEP).
2. Basal Ganglia.
3. RF and nuclei of brain stem.

They include Many Tracts:

1. Rubrospinal.
2. Tectospinal.
3. Vestibospinal.
4. Reticulospinal.
5. Olivospinal.



Both CST and COEP (relay in red n.) end on opposite alpha motor n: 90% of fibers end on Interneuron's.
- 10% of fibers end directly.

Other COEP fibers reach: - directly → or via B.G. → inhibitory RF → control γ motor neurons activity.

N.B. CMAs controls LMNs of body muscles by:

- Direct pathway CST.
- Indirect pathway COEP that relay in red n.

While upper face muscles (head) supplied only by pyramidal tract (CBT), (no COEP).

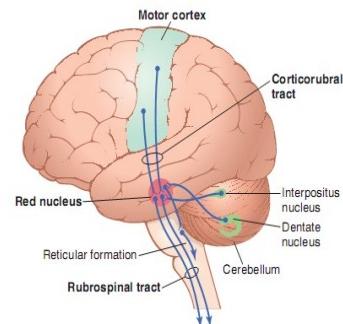
Function of COEP Tract:

Control of axial muscles (neck-trunk) and proximal limb muscles for:

1. Performance of gross voluntary subconscious movement.
2. Movement of head and eyes towards visual or auditory stimuli.
3. Inhibitory to stretch reflex.
4. Postural adjustment to:
 - a) Maintain up-right posture.
 - b) Maintain equilibrium.
 - c) Provide the background of skilled acts.

N.B: Extra pyramidal system=Tract+CMAs

	Direct Activation Pathway	Indirect Activation Pathway
1. Origin	Only cortical	COEP + extra cortical B.G.+Br. Stem
2. Crossing	Nearly all crossed	About 50% crossed.
3. Tract	Mono-neuronal	Multi-neuronal
4. Termination	A.H.C.+ Br. Stem	A.H.C.
5. Function	a) Excitatory to Stretch R. b) Control of fine discrete movement N.B: start function after age of one year, after myelination.	a) Inhibitory to Stretch R. b) Control of gross and skilled movement+ autonomic + visceral. N.B: start function at birth.
6. Lesion	Both Lost together = UMNL (No practical separate lesion)	



Rubrospinal Tract

Function of Rubrospinal Tract

- o Serves as an accessory route for transmission of relatively discrete signals from motor cortex to spinal cord (for performance of fine skilled movements).
- o It transmits action potentials involved in the comparator function of cerebellum.

- o Inhibits stretch reflex and muscle tone.
- o Activate flexors and inhibit extensors

Damage of lateral corticospinal fibers with intact rubrospinal pathway

Impaired fine movements of fingers and hands + intact wrist movements

Lesion in both lateral corticospinal and rubrospinal pathways

Loss wrist movements and fine movements of fingers and hands

Reticulospinal Tract

Function of Reticulospinal Tract

- Maintenance of posture
- Modulate muscle tone, especially via influence on γ -motor neurons.

Pontine reticulospinal tract:

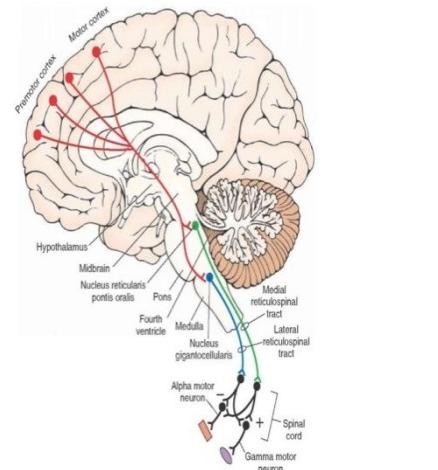
Excitatory ($\uparrow\uparrow$ muscle tone in antigravity muscles)

Spontaneously active

Medullary reticulospinal tract:

Inhibitory ($\downarrow\downarrow$ muscle tone in antigravity muscles)

Normally, the inhibitory signals from medullary reticular inhibitory system counterbalance the excitatory signals from pontine reticular system. *so under normal conditions the body muscles are not abnormally tense.*



Tectospinal Tract

Function of Tectospinal Tract

Controls head and eye movements

- Reflex turning of head in response to visual stimulus
- Reflex shift of head in response to auditory stimulus

Vestibulospinal Tract

Function of Vestibulospinal Tract

- Involved in vestibular function
- It activates motor neurons to antigravity muscles (trunk and proximal limb extensors) to control posture and balance.

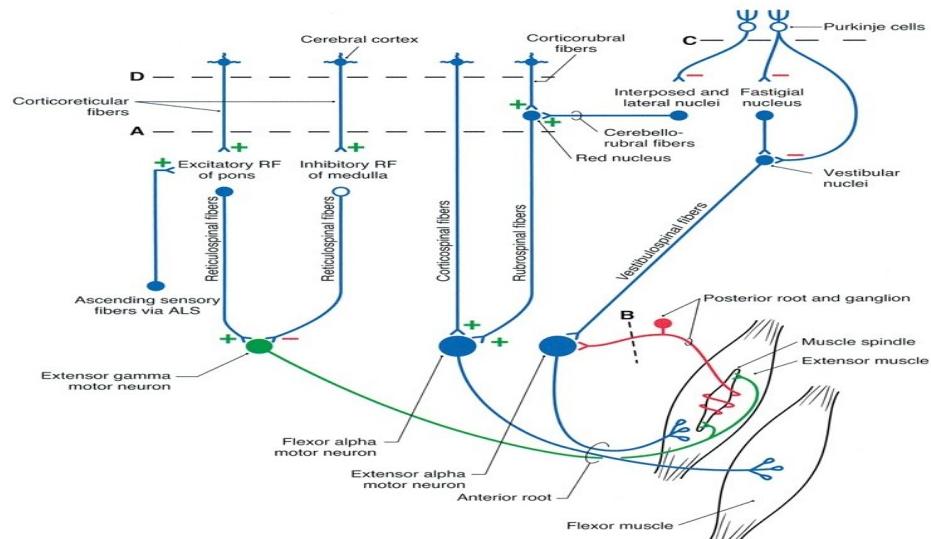
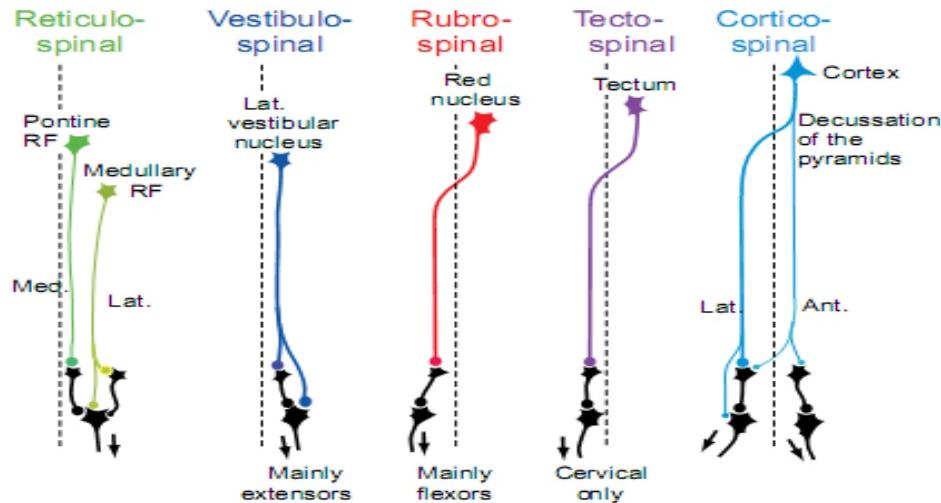
The motor descending tracts

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- Facilitation of the muscle tone.

Vestibulospinal Tract functions in association with the pontine reticular nuclei to control antigravity muscles.

Without this support of vestibular nuclei, the pontine reticular system would lose much of its excitation of axial antigravity muscles.



Lesion/Motor response

- A = Extensor rigidity in all limbs, decerebrate rigidity/posturing
- A+B = Relaxation of extensor rigidity in limb with sectioned root
- A+C = Slight enhancement of decerebrate rigidity compared to A
- A+C+B = No relaxation of decerebrate rigidity
- D = Flexion of upper limbs, extension of lower limbs, decorticate rigidity/posturing

Source: Barrett KE, Barman SM, Boitano S, Brooks H: *Ganong's Review of Medical Physiology*,
23rd Edition: <http://www.accessmedicine.com>

SUGGESTED TEXTBOOKS

1. Guyton and Hall textbook of medical physiology, thirteenth edition 2016, Elsevier, chapter 56 , from page 707 to 719
2. Ganong's Review of Medical Physiology, twenty-fifth edition 2016, McGraw-Hill Education, chapter 12, from page 227 to 254